[0052] It will be seen, therefore, that the transmissionless variable output pumping unit of the present invention is well adapted to carry out the ends and advantages mentioned as well as those inherent therein. While several preferred embodiments have been shown for the purposes of this disclosure, numerous changes may be made by those skilled in the art. All such changes are encompassed with the scope and spirit of the appended claims.

[0053] What is claimed is:

1. A pumping apparatus comprising:

a first cylinder;

a second cylinder;

a first plunger reciprocably disposed in the first cylinder and adapted for pumping fluid from the first cylinder;

a second plunger reciprocably disposed in the second cylinder and adapted for pumping fluid from the second cylinder;

a first crankshaft connectable to a prime mover and connected to the first plunger;

a second crankshaft connectable to the prime mover and connected to the second plunger; and

an adjustment mechanism connected to at least one of the first and second crankshafts such that a phase angle between the first and second crankshafts may be adjusted.

2. The apparatus of claim 1 wherein the phase angle may be adjusted between minimum and maximum phase angles corresponding respectively to maximum and minimum pumping rates for the first and second plungers.

3. The apparatus of claim 2 wherein the phase angle may be infinitely adjusted between the minimum and maximum phase angles.

4. The apparatus of claim 2 wherein the minimum phase angle is zero.

5. The apparatus of claim 1 wherein the first and second cylinders are coaxial.

6. The apparatus of claim 1 wherein the first and second cylinders have substantially the same diameter.

7. The apparatus of claim 1 wherein the first and second cylinders are angularly disposed to one another.

8. The apparatus of claim 7 wherein the first and second cylinders are disposed at a 90 degree angle from one another.

9. The apparatus of claim 1 further comprising a drive train connecting the first and second crankshafts to the prime mover.

10. The apparatus of claim 9 wherein the drive train comprises:

a first drive shaft driven by the prime mover;

a second drive shaft driven by the prime mover;

a first gear train connected between the first drive shaft and the first crankshaft; and

a second gear train connected between the second drive shaft and the second crankshaft.

11. The apparatus of claim 10 wherein:

the first gear train comprises a first planetary gear train having a fixed first outer housing;

the second gear train comprises a second planetary gear train having a second outer housing; and

an angular adjustment of the second outer housing corresponds to the phase angle.

12. The apparatus of claim 11 wherein the adjustment mechanism comprises a lever extending from the second outer housing.

13. The apparatus of claim 11 wherein:

the second outer housing has an outer geared surface; and

the adjustment mechanism comprises a spur gear engaged with the outer geared surface.

14. The apparatus of claim 11 wherein:

the second outer housing has an outer geared surface; and

the adjustment mechanism comprises a worm gear engaged with the outer geared surface.

15. A pumping apparatus comprising:

a first cylinder;

a second cylinder;

an inlet port in communication with the first and second cylinders;

an inlet valve disposed in the inlet port whereby fluid from the inlet port may enter the first and second cylinders;

a discharge port in communication with the first and second cylinders;

a discharge valve disposed in the discharge port whereby fluid may be discharged from the first and second cylinders to the discharge port;

a first plunger reciprocably disposed in the first cylinder and adapted for drawing fluid into the first cylinder through the inlet valve and pumping fluid from the first cylinder through the discharge valve;

a second plunger reciprocably disposed in the second cylinder and adapted for drawing fluid into the second cylinder through the inlet valve and pumping fluid from the second cylinder through the discharge valve;

a first crankshaft connectable to a prime mover and connected to the first plunger;

a second crankshaft connectable to the prime mover and connected to the second plunger; and

an adjustment mechanism connected to at least one of the first and second crankshafts such that a phase angle between the first and second crankshafts may be adjusted.

16. The apparatus of claim 15 wherein the phase angle may be adjusted between minimum and maximum phase angles corresponding respectively to maximum and minimum pumping rates for the first and second plungers.

17. The apparatus of claim 16 wherein the phase angle may be infinitely adjusted between the minimum and maximum phase angles.

18. The apparatus of claim 16 wherein the minimum phase angle is zero.

19. The apparatus of claim 16 wherein the first and second plungers reach top dead center substantially simultaneously and reach bottom dead center substantially simultaneously when the phase angle is at the minimum phase angle.

20. The apparatus of claim 16 wherein the first plunger reaches top dead center when the second plunger reaches bottom dead center and the first plunger reaches bottom dead center when the second plunger reaches top dead center when the phase angle is the maximum phase angle.

21. The apparatus of claim 15 wherein the first and second cylinders are coaxial.

22. The apparatus of claim 21 wherein a maximum phase angle is 180 degrees.

23. The apparatus of claim 15 wherein the first and second cylinders have substantially the same diameter.

24. The apparatus of claim 15 wherein the first and second cylinders are angularly disposed to one another.

25. The apparatus of claim 24 wherein the first and second cylinders are disposed at a 90 degree angle from one another.

26. The apparatus of claim 15 further comprising a drive train connecting the first and second crankshafts to the prime mover.

27. The apparatus of claim 26 wherein the drive train comprises:

a first drive shaft driven by the prime mover;

a second drive shaft driven by the prime mover;

a first gear train connected between the first drive shaft and the first crankshaft; and

a second gear train connected between the second drive shaft and the second crankshaft.

28. The apparatus of claim 27 wherein:

the first gear train comprises a first planetary gear train having a fixed first outer housing;

the second gear train comprises a second planetary gear train having a second outer housing; and

an angular adjustment of the second outer housing corresponds to the phase angle.

29. The apparatus of claim 28 wherein the adjustment mechanism comprises a lever extending from the second outer housing.

30. The apparatus of claim 28 wherein:

the second outer housing has an outer geared surface; and

the adjustment mechanism comprises a spur gear engaged with the outer geared surface.

31. The apparatus of claim 28 wherein:

the second outer housing has an outer geared surface; and

the adjustment mechanism comprises a worm gear engaged with the outer geared surface.

32. A method of adjusting a flow rate of a pump, comprising the steps of:

providing a first crankshaft connected to a first plunger, wherein the first plunger is disposed in the pump;

providing a first drive shaft connectable to a primer mover;

providing a first planetary gear reducer having a first outer housing, wherein the first planetary gear reducer is connected between the first drive shaft and the first crankshaft;

providing a second crankshaft connected to a second plunger, wherein the second plunger is disposed in the pump;

providing a second drive shaft connectable to the primer mover;

providing a second planetary gear reducer having a second outer housing, wherein the second planetary gear reducer is connected between the second drive shaft and the second crankshaft; and

adjusting a phase angle between the first and second crankshafts to adjust the flow rate of the pump.

33. The method of claim 32 wherein the phase angle may be adjusted between minimum and maximum phase angles corresponding respectively to maximum and minimum flow rates of the pump.

34. The method of claim 33 wherein the phase angle may be infinitely adjusted between the minimum and maximum phase angles.

35. The method of claim 32 wherein the step of adjusting the phase angle between the first and second crankshafts comprises the step of rotating the second outer housing about the second drive shaft.